

WHAT IS CLAIMED IS:

1. A method for dynamically adjusting a beam of an adaptive antenna array, the method comprising:
 - receiving in a receiving node, via a plurality of antenna array elements, a signal from a transmitting node;
 - digitizing the received signal from the antenna array elements;
 - recording the digitized received signal;
 - generating $k+1$ output signals from the recorded digitized signal, by applying each of a plurality of weight sets to the digitized signal, each of the weight sets corresponding to a different one of k known neighboring nodes and a weight set for generating an omnidirectional propagation pattern;
 - determining which one of the $k+1$ output signals to process; and
 - processing the one of the $k+1$ output signals and decoding a packet encoded in the one of the $k+1$ output signals.
2. The method of claim 1, wherein the determining further comprises:
 - finding an error-free one of the $k+1$ output signals, and
 - determining that the error-free one of the $k+1$ output signals is the one of the $k+1$ output signals to process.
3. The method of claim 1, wherein the determining further comprises:
 - finding a strongest one of the $k+1$ output signals, and

determining that the strongest one of the $k+1$ output signals is the one of the $k+1$ output signals to process.

4. The method of claim 1, further comprising:

when the decoded packet includes location information of the transmitting node:

determining whether a line-of sight connection exists with the transmitting node;

when the determining determines that the line-of sight connection exists:

using the location information to estimate a position of the transmitting node, and

adjusting the weight set corresponding to the transmitting node based on the estimated position of the transmitting node.

5. The method of claim 4, wherein:

the decoded packet including the location information is a heartbeat packet.

6. The method of claim 4, wherein the location information includes a reported position and a reported velocity of a transmitting node.

7. The method of claim 4, wherein:

the determining whether a line-of-sight connection exists comprises:

estimating an angle to the transmitting node, and

determining whether the estimated angle to the transmitting node corresponds to a reported position of the transmitting node, included in the location information.

8. The method of claim 4, wherein
when the determining whether a line-of sight connection exists determines that a line-of-sight connection does not exist:

using a last known location of the transmitting node as an estimate of a position of the transmitting node, and

adjusting weights of the weight set corresponding to the transmitting node based on the estimate of the position of the transmitting node.

9. The method of claim 4, wherein
when the determining whether a line-of sight connection exists determines that a line-of-sight connection does not exist:

determining whether the transmitting node is moving,

when the determining whether the transmitting node is moving determines that the transmitting node is not moving:

using a last known location of the transmitting node as an estimate of a position of the transmitting node, and

adjusting weights of the weight set corresponding to the transmitting node based on the estimate of the position of the transmitting node.

10. The method of claim 4, wherein
- when the determining whether a line-of sight connection exists determines that a line-of-sight connection does not exist:
- determining whether the transmitting node is moving,
- when the determining whether the transmitting node is moving determines that the transmitting node is moving:
- providing a predictive filter with information concerning past movement of the transmitting node,
- providing, by the predictive filter, an estimated position of the transmitting node, and
- adjusting the weight set corresponding to the transmitting node based on the estimated position of the transmitting node.
11. The method of claim 10, wherein:
- the predictive filter includes a Kalman filter.
12. The method of claim 10, wherein:
- adjusting the weight set further comprises adjusting the weight set based on an uncertainty of the estimated position provided by the predictive filter.
13. The method of claim 1, wherein the receiving comprises:
- detecting, by each of the array elements, a beginning of a packet.

14. The method of claim 13, wherein the detecting a beginning of a packet comprises:

detecting at least a predetermined radio frequency signal strength and detecting at least some acquisition and timing bits in a packet header.

15. The method of claim 1, wherein the recording comprises:

storing the digitized received signal in a memory.

16. The method of claim 1, wherein:

the receiving node and the transmitting node are included in a wireless ad hoc network.

17. A node configured to operate in a wireless network, the node comprising:
a transceiver including a plurality of antenna array elements and a memory, the transceiver being configured to:

receive, from a transmitting node, a signal via the plurality of antenna array elements and detect a beginning of a packet in the signal, and

store, in the memory, respective portions of the signal received via corresponding ones of the antenna array elements, and

a processor connected to the transceiver and configured to:

access the stored portions of the received signal from the memory,

generate output signals based on the stored portions of the received signal, wherein each of the output signals is generated using a different one of a plurality of weight sets, the weight sets corresponding to k known neighboring nodes and a weight set for generating an omnidirectional propagation pattern,

determine which one of the $k+1$ output signals to process, and

process the one of the $k+1$ output signals and decode the packet encoded in the one of the $k+1$ output signals.

18. The node of claim 17, wherein the processor being configured to determine which one of the $k+1$ output signals to process, further comprises the processor being configured to:

find an error-free one of the $k+1$ output signals, and

determine that the error-free one of the $k+1$ output signals is the one of the $k+1$ output signals to be processed.

19. The node of claim 17, wherein the processor being configured to determine which one of the $k+1$ output signals to process, further comprises the processor being configured to:

find a strongest one of the $k+1$ output signals, and

determine that the strongest one of the $k+1$ output signals is the one of the $k+1$ output signals to be processed.

20. The node of claim 17, wherein the processor is further configured to:

determine whether the decoded packet includes location information of a transmitting node,

when the processor determines that the decoded packet includes the location information, the processor is further configured to:

determine whether the plurality of antenna array elements are receiving a line-of-sight signal from the transmitting node,

when the processor determines that the plurality of antenna array elements are receiving a line-of-sight signal, the processor is further configured to:

estimate a position of the transmitting node based on the heartbeat packet, and

adjust the weight set corresponding to the transmitting node based on the estimated position of the transmitting node.

21. The node of claim 20, wherein the location information includes a reported position and a reported velocity.

22. The node of claim 17, wherein the transceiver further comprises
a plurality of downconverters, each of the downconverters being coupled to a different one of the antenna array elements,
a plurality of analog-to-digital converters, each of the analog-to-digital converters being coupled to a different one of the downconverters, and
a memory coupled to the analog-to-digital converters and further coupled to the processor, wherein:

the downconverters are configured to receive the portions of the signal from the ones of the antenna array elements and downconvert the portions of the received signal from a radio frequency to a baseband frequency, and

the analog-to-digital converters are configured to digitize the downconverted portions of the received signal and to store the portions of the digitized downconverted signal in the memory.

23. The node of claim 20, wherein:

the processor being configured to determine whether the plurality of antenna array elements are receiving a line-of-sight signal from the transmitting node, further comprises the processor being configured to:

estimate an angle from the antenna array elements to the transmitting node, and

determine whether the estimated angle corresponds to the location information.

24. The node of claim 20, wherein:

when the processor determines that the plurality of antenna elements are not receiving a line-of-sight signal from the transmitting node, the processor is further configured to:

use a last known location of the transmitting node as an estimate of the position of the transmitting node, and

adjust weights of the weight set corresponding to the transmitting node based on the estimate of the position of the transmitting node.

25. The node of claim 20, wherein:

when the processor determines that the plurality of antenna elements are not receiving a line-of-sight signal from the transmitting node, the processor is further configured to:

determine whether the transmitting node is moving,

when the processor determines that the transmitting node is not moving,

the processor is further configured to:

use a last known location of the transmitting node as an estimate of the position of the transmitting node, and

adjust weights of the weight set corresponding to the transmitting node based on the estimate of the position of the transmitting node.

26. The node of claim 20, wherein:

when the processor determines that the plurality of antenna elements are not receiving a line-of-sight signal from the transmitting node, the processor is further configured to:

determine whether the transmitting node is moving,

when the processor determines that the transmitting node is moving, the processor is further configured to:

provide a predictive filter with information concerning past movement of the transmitting node,
receive an estimated position of the transmitting node from the predictive filter, and
adjust the weight set pertaining to the transmitting node based on the estimated position of the transmitting node.

27. The node of claim 26, wherein
the processor being configured to determine whether the transmitting node is moving, further comprises the processor being further configured to:
determine whether a reported velocity, included in the location information, is non-zero.
28. The node of claim 26, wherein
the predictive filter includes a Kalman filter.
29. The node of claim 26, wherein the processor being configured to adjust the weight set corresponding to the transmitting node based on the estimated position of the transmitting node, further comprises the processor being configured to:
adjust the weight set corresponding to the transmitting node based on uncertainty of the estimated position of the transmitting node from the predictive filter.

30. The node of claim 17, wherein the transceiver being configured to detect a beginning of a packet, further comprises the transceiver being configured to:

detect a radio frequency signal having at least a predetermined signal strength and detecting at least some acquisition and timing bits in a packet header.

31. A machine-readable medium having instructions recorded thereon for a processor, when the instructions are executed by the processor, the processor is configured to:

access a plurality of recorded waveforms in a memory, each of the recorded waveforms having been received via a different one of a plurality of antenna array elements,

apply each of $k+1$ weight sets to the recorded waveforms to generate $k+1$ output signals, k of the weight sets corresponding to k known neighboring nodes and one of the weight sets being a predetermined weight set for generating an omnidirectional propagation pattern, and

determine which one of the $k+1$ output signals to process and process the determined one of the $k+1$ output signals, the processing including decoding a received packet encoded in the one of the $k+1$ output signals.

32. The machine-readable medium of claim 31, the processor being configured to determine which one of the $k+1$ output signals to process further comprises the processor being configured to:

find an error-free one of the $k+1$ output signals, and

determine that the error-free one of the $k+1$ output signals is the one of the $k+1$ output signals to process.

33. The machine-readable medium of claim 31, the processor being configured to determine which one of the $k+1$ output signals to process further comprises the processor being configured to:

find a strongest one of the $k+1$ output signals, and
determine that the strongest one of the $k+1$ output signals is the one of the $k+1$ output signals to process.

34. The machine-readable medium of claim 31, the processor further being configured to:

determine whether the decoded packet includes location information of a transmitting node,
when the decoded packet is determined to include the location information, the processor is further configured to:

determine whether a line-of-sight connection exists with a transmitting node,

when the processor determines that the line-of sight connection exists, the processor is further configured to:

estimate a position of the transmitting node based on the location information, and

adjust weights of the weight set corresponding to the transmitting node based on the estimated position of the transmitting node.

35. The machine-readable medium of claim 34, wherein the location information includes a reported position and a reported velocity.

36. The machine-readable medium of claim 34, wherein the processor being configured to determine whether a line-of-sight connection exists, further comprises the processor being further configured to:

estimate an angle to a the transmitting node, and

determine whether the estimated angle to the transmitting node corresponds to the location information.

37. The machine-readable medium of claim 36, wherein the processor being configured to estimate the angle to the transmitting node, further comprises the processor being further configured to:

estimate the angle to the transmitting node based on eigenvalues of an array correlation matrix.

38. The machine-readable medium of claim 34, wherein when the processor determines that a line-of-sight connection does not exist, the processor is further configured to:

use a last known location of the transmitting node as an estimate of a position of the transmitting node, and

adjust weights of the weight set corresponding to the transmitting node based on the estimate of the position of the transmitting node.

39. The machine-readable medium of claim 34, wherein when the processor determines that a line-of-sight connection does not exist, the processor further is further configured to:

determine whether the transmitting node is moving,

when the processor determines that the transmitting node is not moving, the processor is further configured to:

use a last known location of the transmitting node as an estimate of a position of the transmitting node, and

adjust weights of the weight set corresponding to the transmitting node based on the estimate of the position of the transmitting node.

40. The machine-readable medium of claim 34, wherein when the processor determines that a line-of-sight connection does not exist, the processor further is further configured to:

determine whether the transmitting node is moving,

when the processor determines that the transmitting node is moving, the processor is further configured to:

use a predictive filter to estimate a position of the transmitting node based on past movement of the transmitting node, and

adjust weights of the weight set corresponding to the transmitting node based on the estimate of the position of the transmitting node determined by the predictive filter.

41. The machine-readable medium of claim 40, wherein the processor being configured to adjust weights of the weight set corresponding to the transmitting node based on the estimate of the position of the transmitting node determined by the predictive filter, further comprises the processor being configured to:

adjust the weights of the weight set corresponding to the transmitting node based on an uncertainty of the estimate of the position determined by the predictive filter.

42. The machine-readable medium of claim 40, wherein the predictive filter includes a Kalman filter.

43. A node configured to operate in a wireless network, the node comprising: /
means for receiving a signal from a transmitting node via a plurality of antenna array elements;
means for storing a representation of the received signal;
means for generating a plurality of output signals by applying each of a plurality of weight sets to the representation of the received signal, k of the weight sets

corresponding to k known neighboring nodes and one of the weight sets being a predetermined weight set for propagating an omnidirectional pattern;

means for determining which one of the plurality of output signals to process; and

means for processing and for decoding the determined one of the plurality of output signals.

44. The node of claim 43, further comprising:

means for determining whether a line-of-sight connection exists with the transmitting node;

means for estimating a position of the transmitting node; and

means for updating the weight set corresponding to the transmitting node based on the estimated position of the transmitting node.